Milford Public Schools Curriculum

Department: Mathematics
Course Name: Algebra 1 Level 3
Course Description:

UNIT 1	
Unit Title: Patterns **Unit Description:** This is the introductory unit for the Algebra I course. You will have the opportunity to learn about your students' mathematical background, ability to work cooperatively, and ability to communicate clearly both orally and in writing. Students will learn mathematical skills within the context of interesting problems that connect to real world issues. Throughout this course, it is hoped that students recognize and appreciate the power of mathematical thinking and how analyzing mathematical models aids in making important decisions. This unit demonstrates how present patterns are in nature and in manmade objects.	
LEARNING GOALS	
Enduring Understanding(s): Analyzing patterns and writing recursive and explicit algebraic rules provides a powerful way to extend patterns and make predictions.	**Essential Question(s):** What is a sequence? How can patterns be represented? What are the advantages and disadvantages of a recursive rule compared to an explicit rule?
Content and Skills: Students will be able to: ● Understand the concept of a function and use function notation ● Build a function that models a relationship between two quantities	
Standards Addressed: FIF 3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. FBF 1. Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. FBF 2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.	

UNIT 2

Unit Title: Linear Equations and Inequalities

Unit Description: The material in this unit is the heart of algebraic thinking. Students write, simplify, evaluate, and model situations with linear expressions. Students then examine the concept of equality and use linear equations and linear inequalities to model and solve real-world problems.

The properties of real numbers play a prominent role in this unit. The commutative, associative, and distributive properties are used when students simplify and evaluate expressions and solve multi-step equations. Opposites, reciprocals, and order of operations are used when students evaluate expressions and solve equations. Students revisit rational numbers when they solve equations and inequalities with rational number coefficients and rational number solutions.

LEARNING GOALS

Enduring Understanding(s):	**Essential Question(s):**
We formulate equations and functional relationships to communicate generalizations so that problems can be solved more efficiently. Inverse operations are an integral part of solving equations and inequalities.	How are inverse operations used in solving equations and inequalities? How can we use linear equations and linear inequalities to model real world problems?

Content and Skills:

Students will be able to:

- Interpret the structure of Expressions
- Write expressions in equivalent form to solve problems
- Create equations that describe numbers or relationships
- Solve equations and inequalities in one variable
- Understand solving equations as a process of reasoning and explain the reasoning
- Reason quantitatively and use units to solve problems

Standards Addressed:

8EE 7. Solve linear equations in one variable.
a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form x = a, a = a, or a = b results (where a and b are different numbers).
b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.
ASSE 1. Interpret expressions that represent a quantity in terms of its context.
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity...
ASSE 3. (part) Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
ACED 1. (part) Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear ... functions
ACED 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.
AREI 1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
AREI 3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

NQ 1 Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas....
NQ 2 Define appropriate quantities for the purpose of descriptive modeling.
NQ 3 Choose a level of accuracy appropriate to limitations on measurements when reporting quantities.

UNIT 3

Unit Title: Functions
Unit Description: Students are introduced to the concept of a function in the first investigation of this unit. After identifying relationships that are or are not functions, they learn how to define the domain and range of a function.

LEARNING GOALS

Enduring Understanding(s):	**Essential Question(s):**
Functions are a mathematical way to describe relationships between two quantities that vary	How can functions be used to model real world situations, make predictions, and solve problems? What are the different ways in which functions may be represented? What are the characteristics of a function and how can you use those characteristics to represent the function in multiple ways?

Content and Skills:
Students will be to:

- Create equations that describe numbers or relationships
- Represent and solve equations and inequalities graphically
- Understand the concept of a function and use function notation
- Interpret functions that arise in applications in terms of the context
- Analyze functions using different representations

Standards Addressed:
8F 1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.1
8F 2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.
8F 5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.
ACED 2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
ACED 10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
FIF 1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).
FIF 2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
FIF 4. For a function that models a relationship between two quantities, interpret key Unit 3 Plan CT Algebra I Model

Curriculum Version 3.0 features of graphs and tables in terms of the quantities and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative....*
FIF 5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person hours
it takes to assemble n engines in factory, then the positive integers would be an appropriate domain for the function.*
FIF 7b. Graph square root, cube root, and piece wise defined
functions, including step functions and absolute value functions
FIF 9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

UNIT 4

Unit Title: Linear Functions
Unit Description: Students start Unit 4 by exploring the distinction between linear and nonlinear behavior, and then focus on learning about linear functions. Throughout Unit 4, students derive linear models of real world situations in order to analyze situations, make predictions or solve problems. Analyzing situations often takes the form of identifying the real world meaning of the slope and the *x* and *y* intercepts of a linear model. Making predictions involves evaluating models for a given independent variable (given *x* find *y*), and solving equations for the independent variable given the dependent variable (given *y* find *x*). Problem solving occurs through the use of various representations: algebraic, tabular, graphic and numeric.

LEARNING GOALS

Enduring Understanding(s):	**Essential Question(s):**
Linear functions are characterized by a constant average rate of change (or constant additive change).	What are the different ways that linear functions may be represented? What is the significance of a linear function's slope and y-intercept? How may linear functions model real world situations? How many linear functions help us analyze real world situations and solve practical problems?

Content and Skills:
Students will be able to:
- Interpret functions that arise in applications in terms of the context
- Analyze functions using different representations
- Construct and compare linear [and exponential] models and solve problems
- Interpret expressions for functions in terms of the situation they model

Standards Addressed:
FIF 6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
FIF 7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
a. Graph linear ...functions and show intercepts..
FIF 8. Write a function defined by an expression in different but equivalent forms to reveal and explain different

properties of the function.
FLE 1. Distinguish between situations that can be modeled with linear functions [and with exponential functions].
a. Prove that linear functions grow by equal differences over equal intervals...
b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another....
FLE 2. Construct linear ... functions, including arithmetic ... sequences, given a graph, a description of a relationship, or two input output pairs (include reading these from a table).
FLE 5. Interpret the parameters in a linear ... function in terms of a context

UNIT 5

Unit Title: System of Linear Equations
Unit Description: In previous units, students studied linear functions and used a linear function to investigate the relationship between two variables. In this unit, students will represent, compare and analyze two linear equations, look for common solutions and use this information to make choices between competing situations in real world contexts. Students will solve systems of equations numerically, graphically, and algebraically. They will be able to explain what the solution of a system of linear equations represents in the context of various applications such as those used by business leaders, economists, scientists, engineers, nutritionists, racecar drivers, and athletes. They also will explore the special cases of parallel lines (no solution) and identical lines (infinite solutions).

LEARNING GOALS

Enduring Understanding(s):
A system of linear equations is an algebraic way to compare two equations that model a situation and find the breakeven point or choose the most efficient or economical plan.

There are a variety of factors to consider when solving systems of equations

There are a variety of solutions to systems of equations ranging from no solution to infinite solutions.

Essential Question(s):
What does the number of solutions (none, one or infinite) of a system of linear equations represent?

What are the advantages and disadvantages of solving a system of linear equations graphically vs algebraically?

What types of relationships can be modeled by systems of linear graphs?

How can we use expressions, equations, and inequalities to model and solve real world problems?

Content and Skills:
Students will be able to:
- Create equations that describe numbers or relationships
- Solve systems of equations
- Represent and solve equations and inequalities graphically

Standards Addressed:
ACED 3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
AREI 5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
AREI 6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
AREI 11. Explain why the x-coordinates of the points where the graphs of the equations $y= f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear

functions.

UNIT 6

Unit Title: Scatterplots and Trend Lines

Unit Description: Students will begin the unit by exploring measures of central tendency and spread and displays of one variable data including, dot plots, histograms, and box-and-whisker plots. They will use the five number summary to create box-and-whisker plots and identify outliers. Students will be introduced to scatter plots and trend lines. They will use the equation of the trend line to make predictions by interpolating or extrapolating. The students will develop a deeper understanding about the meaning of the slope and intercepts in context. They will use technology (either a graphing calculator or a spreadsheet) to calculate the linear regression equation and to find the correlation coefficient. The students will be able to interpret the meaning of the correlation coefficient and explain the difference between correlation and causation. Students will perform experiments in which they collect and analyze data using linear models. Students will work with data sets that contain outliers to identify the influence that outliers have on the calculation and interpretation of the slope, y-intercept, linear regression equation, and correlation coefficient.

LEARNING GOALS

Enduring Understanding(s):
Although scatter plots and trend lines may reveal a pattern, the relationship of the variables may indicate a correlation, but not causation.

Essential Question(s):
How do we make predictions and informed decisions based on current numerical information?

What are the advantages and disadvantages of analyzing data by hand versus by using technology?

What is the potential impact of making a decision from data that contains one or more outliers?

Content and Skills:
- Analyze functions using different representations
- Summarize, represent, and interpret data on a single count or measurement variable
- Summarize, represent, and interpret data on two categorical and quantitative variables
- Interpret linear models

Standards Addressed:
SID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).
SID 2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
SID 3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
SID 6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Fit a linear function for a scatter plot that suggests a linear association.
SID 7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
SID 8. Compute (using technology) and interpret the correlation coefficient of a linear fit.
SID 9. Distinguish between correlation and causation.

UNIT 7

Unit Title: Introduction to Exponential Functions

Unit Description: Unit 7 builds on the concepts of a function and patterns of change. Students work with interesting and significant relationships that are exponential in nature. Many of the contexts explored affect their daily lives. The unit begins with the topic of world population growth and food supply to compare the growth rates of exponential and linear models. This context follows the theme of world hunger and nutrition from the previous unit. Students begin to recognize that real world data is a bit messy and data patterns over restricted domains may be modeled with different functions.

LEARNING GOALS

Enduring Understanding(s):
When comparing an exponential model with a linear model, the question is not if the exponential model will generate very large or very small inputs, but rather when.

With real data, sometimes deciding whether data is linear or nonlinear is more complex than just looking at a graph, differences (y n – y n1), or an r-value; it is important to examine differences that are approximately the same more carefully to see if there is a pattern of increasing or decreasing values that, because the pattern is exponential, soon begins to produce outputs of remarkable values.

Essential Question(s):
What characterizes exponential growth and decay and how can we use them in the real world?

How can we differentiate an exponential model from a linear model given a real world data set?

Content and Skills:
Students will be able:
- Extend the properties of exponents to rational exponents.
- Interpret the structure of expressions
- Write expressions in equivalent forms to solve problems
- Analyze functions using different representations
- Build a function that models a relationship between two quantities
- Construct and compare linear and exponential models and solve problems
- Interpret expressions for functions in terms of the situation they model

Standards Addressed:
NRN 1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 5 1/3 to be the cube root of 5 because we want (5 1/3) 3= 5 (1/3)3 to hold, so (5 1/3) 3 must equal 5.
NRN 2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.
ASSE 1b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r) n as the product of P and a factor not depending on P.
ASSE 3c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15 t can be rewritten as [1.15 (1/12)] (12t) ≈1.012 (12t) to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
FIF 7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
FIF 8b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02) t , y = (0.97) t , y = (1.01) 12t , y = (1.2) (t/10) , and classify them as representing exponential functions.
FBF 2. Write ... geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
FLE 1. Distinguish between situations that can be modeled with linear functions and with exponential functions.
FLE 2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a

description of a relationship, or two input-output pairs (include reading these from a table).
FLE 3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly...
FLE 5. Interpret the parameters in a ... exponential function in terms of a context.

UNIT 8

Unit Title: Quadratic Functions and Equations
Unit Description:

LEARNING GOALS

Enduring Understanding(s):

- Quadratic functions can be used to model real world relationships and the key points in quadratic functions have meaning in the real world context.
- Polynomials are closed under addition, subtraction, and multiplication.
- Dynamic software, graphing calculators, and other technology can be used to explore and deepen our understanding of mathematics.

Essential Question(s):

- What can the zeros, intercepts, vertex, maximum, minimum and other features of a quadratic function tell you about real world relationships?
- How is the polynomial system analogous to the system of integers?
- How can technology support investigation and experimentation of the way that parameters effect functions?

Content and Skills:

Standards Addressed:
8EE 2. Use square root and cube root symbols to represent solutions to equations of the form $x2 = p$ and $x3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.
ASSE 3. a Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
AREI 4. a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)2 = q$ that has the same solutions. Derive the quadratic formula from this form. Solve quadratic equations by inspection (e.g., for $x2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation.
AAPR 1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
ACED 1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from ...quadratic functions ...*
ACED 2. Create equations in two or more variables to represent relationships between

quantities; graph equations on coordinate axes with labels and scales.
FIF 4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries... *
FIF 7a. Graph ... quadratic functions and show intercepts, maxima, and minima.
FIF 8a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
FBF 3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology...